Understanding and Responding to Biological Threats

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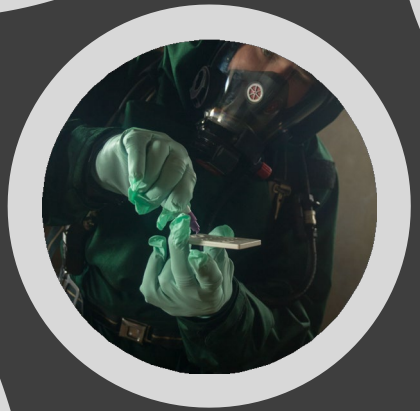

UNDERSTANDING & RESPONDING TO BIOLOGICAL THREATS

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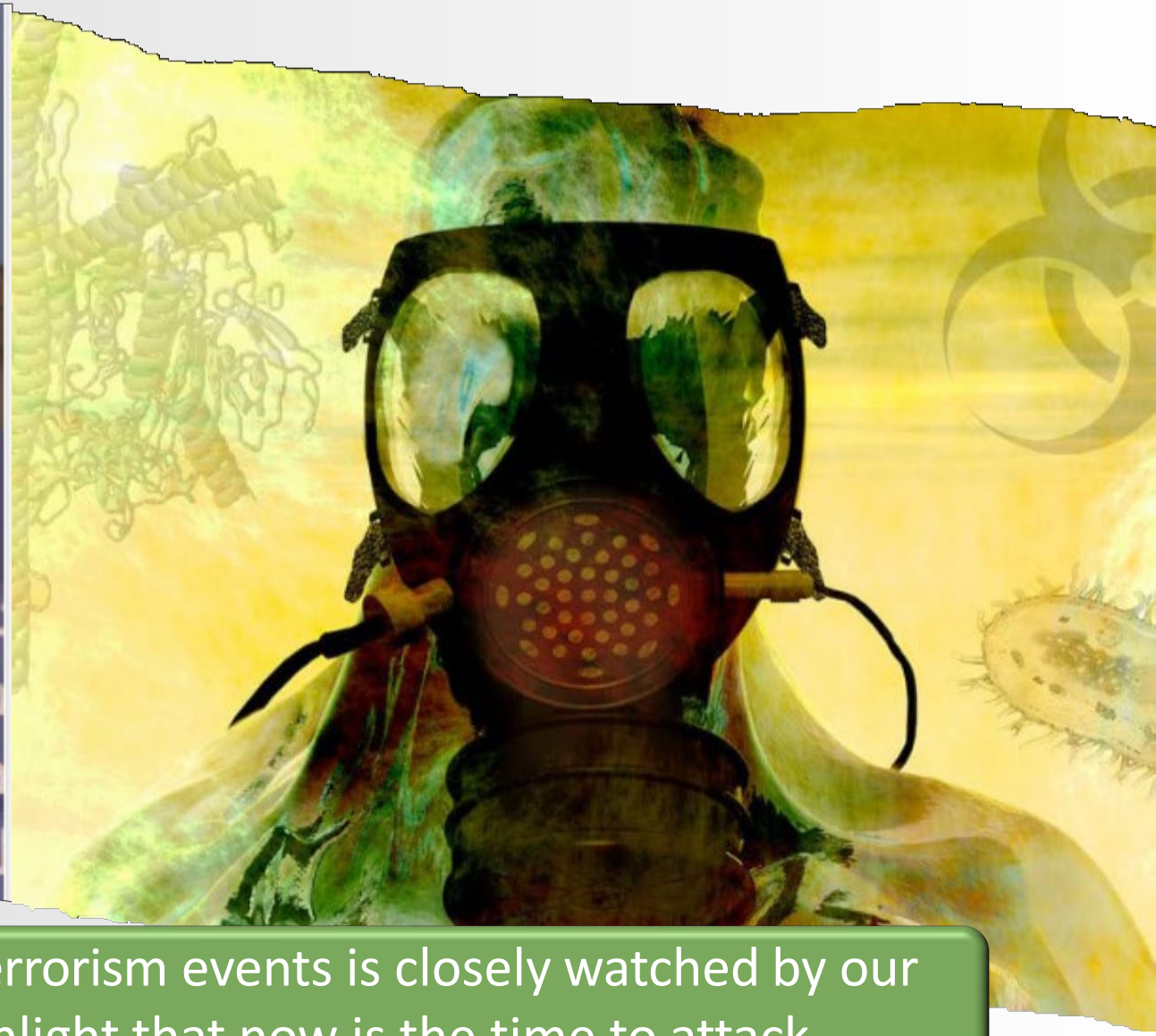
Now that the Façade's all Cracked…



Our response to COVID and Domestic Terrorism events is closely watched by our adversaries…They continuously highlight that now is the time to attack.

REF: ISIS Naba Editorial, "War with Crisis-Ridden America, January 7, 2021

REF: SITE, April 2020

The World We Live In…

International forums discussed ways to propagate the Corona Virus with specific targets of the public safety, military, and medical communities (“Easy Targets”)

REF: Greenb1rds media outlet, March 2020

REF: Voice of Hind magazine (India), April 2020

The Threat from Within…

Domestic forums specified ways to spread the virus with specific targets of politicians, police, and the medical community

REF: White Supremacy Channels, Telegram, JAN-MAR 2020

Emerging Microbial Threats

- Recent decades have witnessed the appearance of dozens of infectious diseases that were previously unrecognized or that attained new geographic reach, incidence, or severity – including antimicrobial resistance
  - Increasing population size and density
  - More rapid and frequent travel
  - Increased number of vulnerable individuals
  - Growing global commerce
  - Mass production in agriculture
  - Changes in land use and human habitats

- HIV – Chimpanzees, 1st known human case 1959 (DRC)
- Ebola/Marburg – bats as the possible reservoir, first outbreak 1976 in central Africa
- SARS-CoV-1 & SARS-CoV-2 – China
- Avian Influenza (H7N9 – China 612 deaths by Sept 2017)
- Methicillin-resistant Staphylococcus aureus (MRSA)
- Zika
- Hemorrhagic Coronavirus

Naturally occurring pathogens have spilled into humans or have evolved in the human population

Global Outbreaks Today

Occurring around the World today: Anthrax, Cholera, Foot-and-Mouth Disease, Rift Valley Fever, Polio, Dengue, **Encephalitis**, Monkey Pox, H_XN_Y, Swine Fever, Hantavirus, Lassa Fever, and **Coronavirus**

REF: www.globalincidentmap.com, 28 JAN 2021

Current HOT Topics in BioThreats

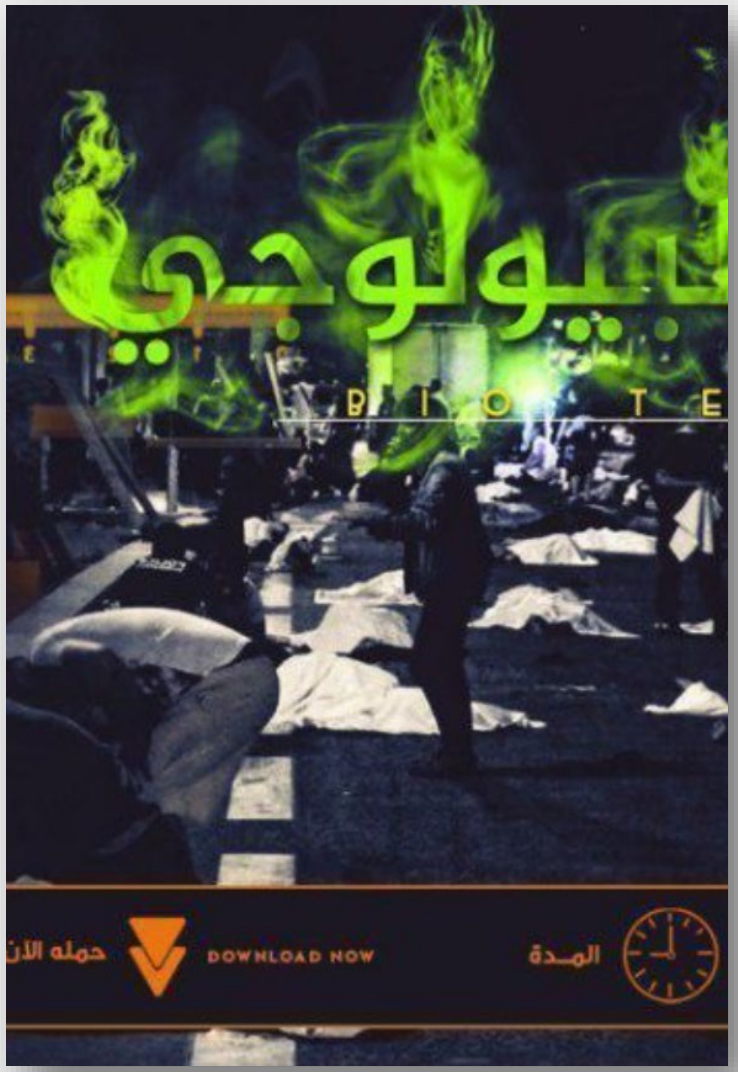
Focus remains on toxins as targeted assassination or small-to-mid scale terrorism tools

Evolving BioThreat

Internet “chatter” focusing on the use of biological weapons remains at an elevated level

REF: Telegram Channel, July 2018

Evolving Biological Threat

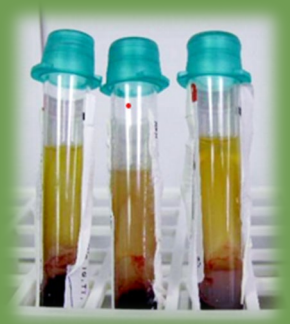


"How To" videos continue to be released with higher level of details effectively removing the need for SMEs

REF: AF Media, August 2018

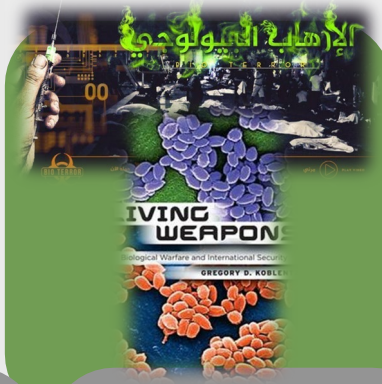
REF: Al Saqri Telegram Channel, September 2018

Creating a Biological Weapon



Acquire Specimens

- Soil from sites of recent outbreaks
- Commercial cultures
- Other scientists
- Universities or hospitals



Access Technical Information

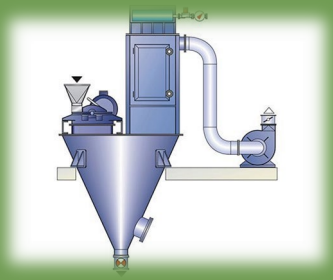
- Internet
- Technical journals

Access Equipment

- Internet
- Laboratory supply
- DIY biology programs
- Catalogues
- Steal from universities and hospitals

Culture and Propagate Agent

- Expertise in bacteria and viruses
- Knowledge of biochemistry and fermentation



Weaponize the Pathogen

- Expertise in airborne materials (milling & isolation)
- Difficult

Disperse Weapons

- UAVs
- Used to be relegated to planes, cars, trucks, etc.

"How To" videos contain guidance from material acquisition through propagation, weaponization, and dispersal

Main Threats of Concern – Ricin

- Ricin (RT) is contained within the seeds of the castor bean plant
  - Ricin toxin is water soluble
- Toxicology
  - $LD_{50(oral)}$: 20 mg/kg
    - Time to death ~ 85 hours
  - Toxic dose (oral) for average human (80 kg): 1.6 g
  - $LD_{50(inh)}$: 3-5 µg/kg
    - Time to death ~ 60 hours
  - Toxic dose (inh) for average human (80 kg): 240 µg
  - $LD_{50(inj)}$: 24 µg/kg
    - Time to death ~ 100 hours
  - Toxic dose (inj) for average human (80 kg): 1.9 mg
  - No dermal toxicity

Inhalation and injection threat

Ricin Plot in Germany – June 2018

Plot to carry out biological attack using RICIN is foiled in Germany

- 29-year-old Tunisian, identified only as Sief Allah H, was arrested on Wednesday
- He had 'started procuring material including seeds needed for creation of ricin'
- Police who searched Cologne flat said he succeeded in creating toxin this month
- Probe continuing into how suspect planned to substance, but prosecutors say he was working on an attack in Germany

Confiscated in Apartment:

- 3,150 castor bean seeds
- 84.3 mg Ricin
- Bomb making components

Ricin as an injection (fragmentation) and inhalation threat

Already in 2021…

Creighton dorm evacuated after student tries to make ricin

Police and firefighters in Omaha, Nebraska, evacuated a Creighton University dormitory after a student told emergency room staff that she had tried to make the poison ricin in her dorm room in an attempt to harm herself

By **The Associated Press**
January 15, 2021, 4:31 PM • 2 min read

An Omaha police officer stands inside of the Davis Square Apartments at Creighton University on Friday, Jan. 15, 2021. Police and firefighters evacuated the dormitory overnight after a student told emergency room staff that she had tried to make the poison ricin in her dorm room in an attempt to harm herself. The Omaha World-Herald reports that officials also shut down the Creighton University Medical Center emergency room on the university campus as a precaution. (Chris Machian/Omaha World-Herald via AP) **Less**

Ingestion as a suicide method…1.6 g ingestion followed by 85 hours to death…

Main Threats of Concern – Abrin

- Abrin is derived from the rosary pea
  - Abrin is water soluble
- Toxicology
  - $LD_{50(oral)}$: 10 - 1000 µg/kg
  - Toxic dose (oral) for average human (80 kg): 0.8 mg
  - $LD_{50(inh)}$: 3.3 µg/kg (mice)
  - Toxic dose (inh) for average human (80 kg): 240 µg
  - $LD_{50(inj)}$: 0.3 µg/kg
  - Toxic dose (inj) for average human (80 kg): 24 µg
  - No dermal toxicity

Inhalation, injection, and ingestion threat

Main Threats of Concern – Saxitoxin (STX)

- Saxitoxin, a potent neurotoxin, in a paralytic shellfish toxin (PST)
  - Resultant illness: Paralytic shellfish poisoning (PSP)
  - Commonly associated with consumption of shellfish contaminated by toxic algal blooms
  - Synthetic production routes are published
  - Also known as chemical weapon TZ
- Toxicology
  - $LD_{50(oral)}$: 5.7 µg/kg
  - Toxic dose (oral) for average human (80 kg): 0.5 mg
  - $LD_{50(inj)}$: ~ 0.6 µg/kg
  - Toxic dose (inj) for average human (80 kg): 50 µg
  - Toxic dose rate (inhalation) for average human (80 kg): 5 mg·min/m³

Inhalation, injection, and ingestion threat

Main Threats of Concern – Tetrodotoxin (TTX)

- TTX causes loss of sensation, and paralysis of voluntary muscles including the diaphragm and intercostal muscles, stopping breathing
- Toxicology
  - The toxin can enter the body of a victim by ingestion, injection, or inhalation, or through abraded skin
  - $LD_{50(oral)}$ for mice: 334 µg/kg
  - $LD_{50(inj)}$ for mice: 8 µg/kg
  - Symptoms typically develop within 30 minutes of ingestion, but may be delayed by up to four hours; however, if the dose is fatal, symptoms are usually present within 17 minutes of ingestion
- In the U.S., tetrodotoxin appears on the select agents list of the Department of Health and Human Services, and scientists must register with HHS to use tetrodotoxin in their research.
  - Investigators possessing less than 500 mg are exempt from regulation

Inhalation, injection, and ingestion threat

Main Threats of Concern – Botulinum Toxin (BTX)

- Toxicology
  - Botulinum toxin is the most poisonous substance known.
  - Intoxication can occur naturally as a result of either wound or intestinal infection or by ingesting preformed toxin in food.
  - $LD_{50(IV\ or\ IM)}$: 1.3–2.1 ng/kg
  - $LD_{50\ (oral)}$: 1000 ng/kg
  - $LD_{50(inh)}$: 10–13 ng/kg
  - Symptoms develop relatively slowly (over several days)
- Weaponization
  - Aum Shinrikyo in 1990

Inhalation, injection, and ingestion threat

Biological Warfare – “Petalominium”

Is there a new agent amongst us?

REF: Telegram Channel, August 2018 (3X)

Petalominium Production

Petalominium = Botulinum; resulted from a phonetic translation

REF: Al Saqri Insitute, August 2018

Toxicity Comparison Across the Toxins

	$LD_{50(inh)}$	$LD_{50(inj)}$	$LD_{50(oral)}$
Ricin	3-5 µg/kg	24 µg/kg	20 mg/kg
Abrin	3.3 µg/kg	0.3 µg/kg	10-1000 µg/kg
Botulinum	**10–13 ng/kg**	**1.3–2.1 ng/kg**	**1 µg/kg**
Saxitoxin	n.d.	0.6 µg/kg	5.7 µg/kg
Tetrodotoxin	n.d.	8 µg/kg	334 µg/kg

Toxicity: BTX >> Abrin/STX > TTX > Ricin

Advanced Biotechnology

- Synthetic biology itself is not harmful - the concern level depends on specific applications and capabilities that it enables
- "The U.S. government should pay close attention to this rapidly progressing field, just as it did to advances in chemistry and physics during the Cold War era"
  - Chair, National Academy of Science Working Group on Emerging Biotechnology Tools (2017)
- Synthetic biology blurs the lines between chemical and biological weapons
  - High potency molecules could be produced through simple genetic pathways and modest resources (e.g. fentanyl produced by engineered yeast)
- Overcoming knowledge barriers is key to malicious use of synthetic biology – Russian publication of *B. anthracis* resistance to antibiotics

Advances in biotechnology need to be monitored closely

Advancing Biotechnology – Concerns

1st (Highest)

- Re-creating known pathogenic viruses
- Making biochemicals via in situ synthesis
- Making existing bacteria more dangerous

2nd

- Making existing viruses more dangerous
- Manufacturing chemicals or biochemicals by exploiting natural metabolic pathways

3rd

- Manufacturing chemicals or biochemicals by creating novel metabolic pathways
- Modifying the human microbiome
- Modifying the human immune system
- Modifying the human genome

4th

- Re-creating known pathogenic bacteria
- Creating new pathogens

5th (Lowest)

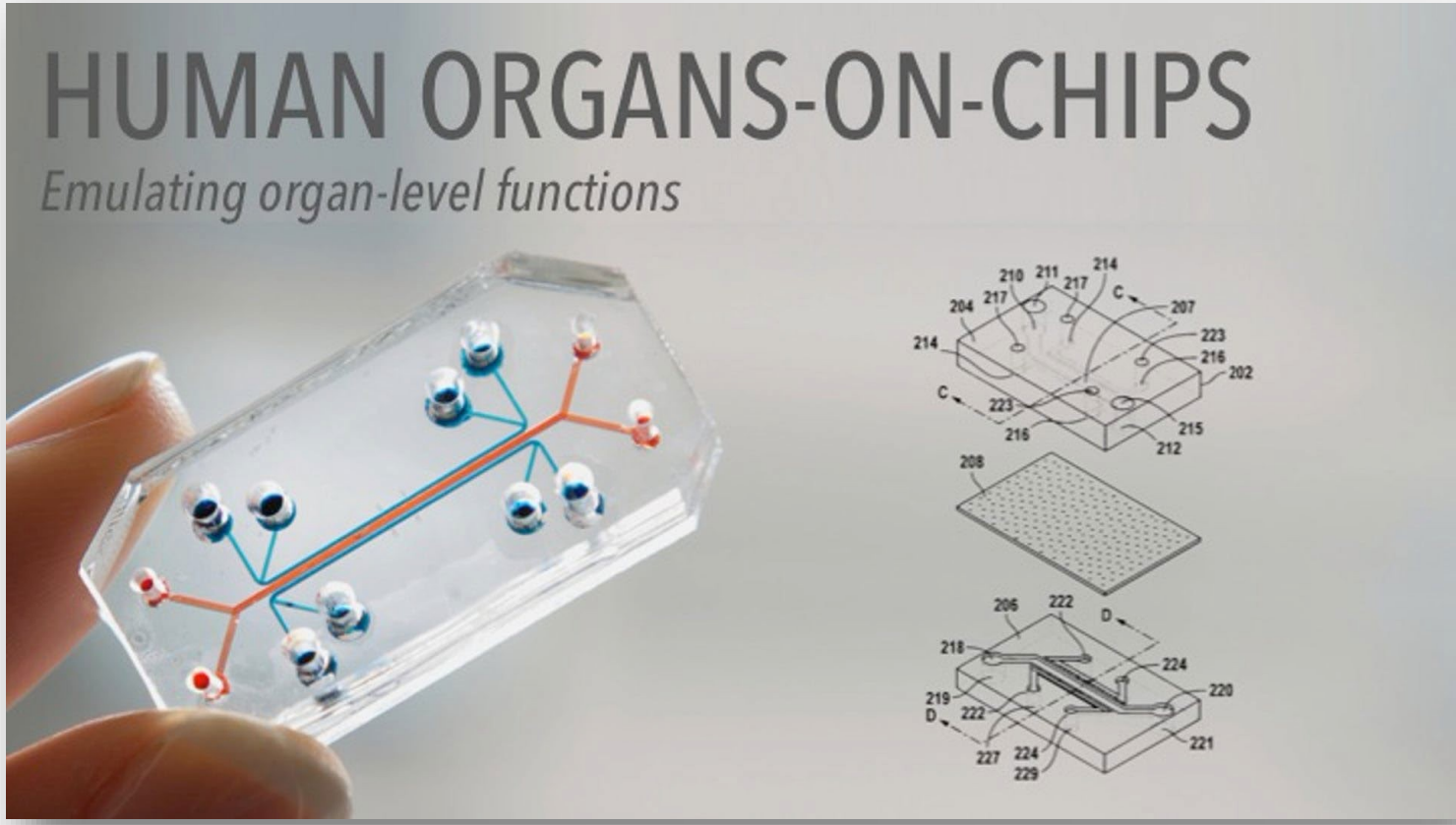
- Modifying the human genome using modified human gene drives

2012 ⇨ increase in dual-use concerns when two research groups elucidated how to increase airborne transmissibility of the Avian H5N1 virus through genetic modification

National Academy of Science Working Group on Emerging Biotechnology Tools (2017)

Advancing Biotechnology – Enabling Equipment

- Microfluidics – chip-scale chemistry involving liquids flowing through and mixing via channels that enable control over reactions and byproducts
  - Implications for biological and chemical weapons
  - Reduces equipment requirements and footprint evading treaty and convention restrictions
  - Enables rapid production on demand and can be used outside of a traditional laboratory



There is no longer a requirement for large scale scientific equipment

Photo Credit: Wyss Institute at Harvard University

Advancing Biotechnology – DIY BIO

Bay Area biologist's gene-editing kit lets do-it-yourselfers play God at the kitchen table

By Lisa M. Krieger | lkrieger@mercurynews.com

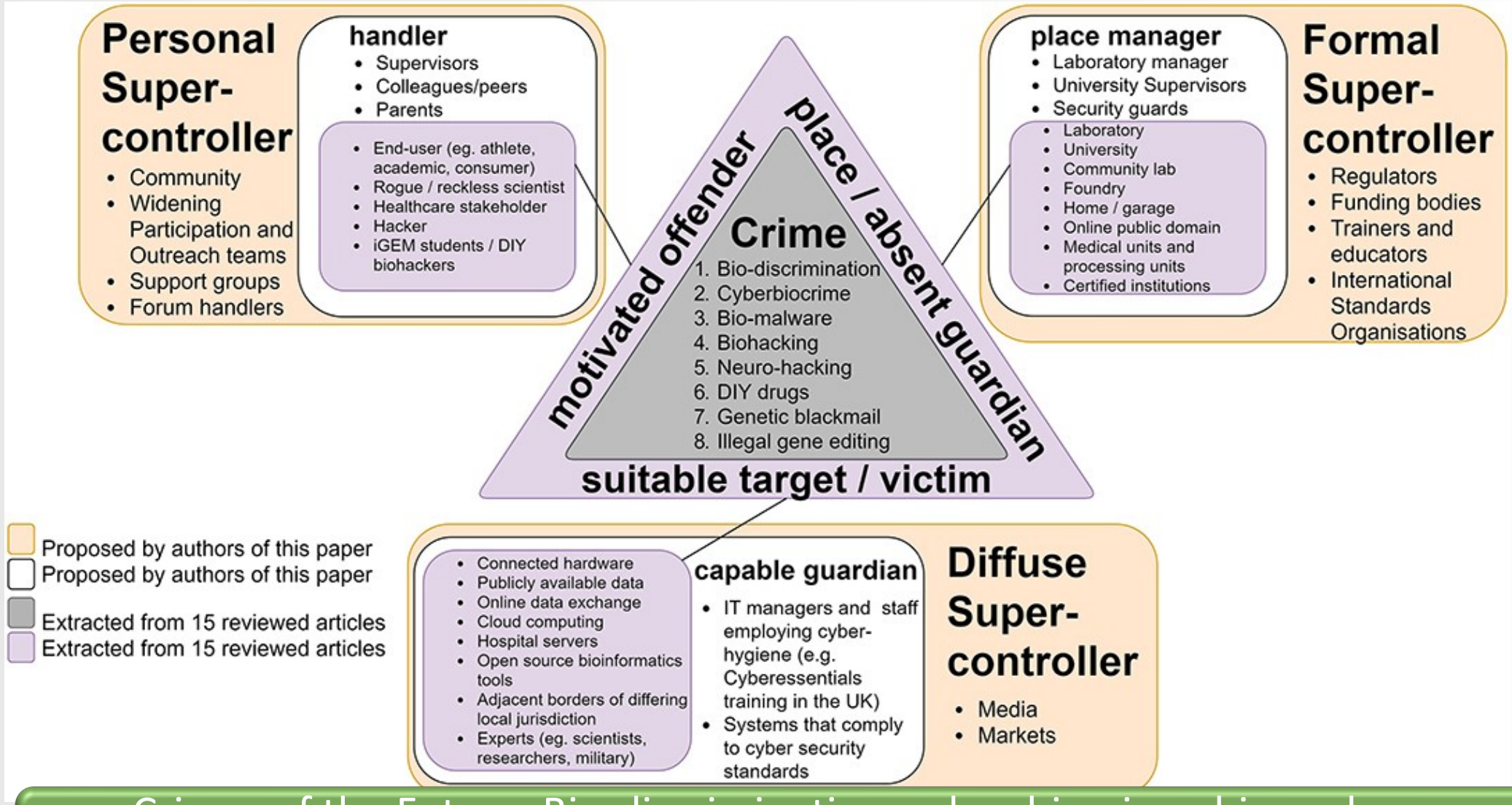
POSTED: 01/11/2016 08:51:59 PM PST | UPDATED: 3 MONTHS AGO

Scientist Josiah Zayner, 34, keeps bacteria engineered to produce human insulin as part of the Open Insulin Project in his refrigerator in Burlingame, Calif., on Tuesday, Dec. 15, 2015. (John Green/Bay Area News Group) (JOHN GREEN)

"I want to democratize science," said Zayner, whose left arm is etched with the tattoo "Build Something Beautiful"

Poly-labs have a major impact on responder safety

Minimizing the Potential Negative Impacts of Synthetic Biology



Crimes of the Future: Bio-discrimination, cyber-biocrime, bio-malware, biohacking, neuro-hacking, DIY drugs, genetic blackmail, and illegal gene editing

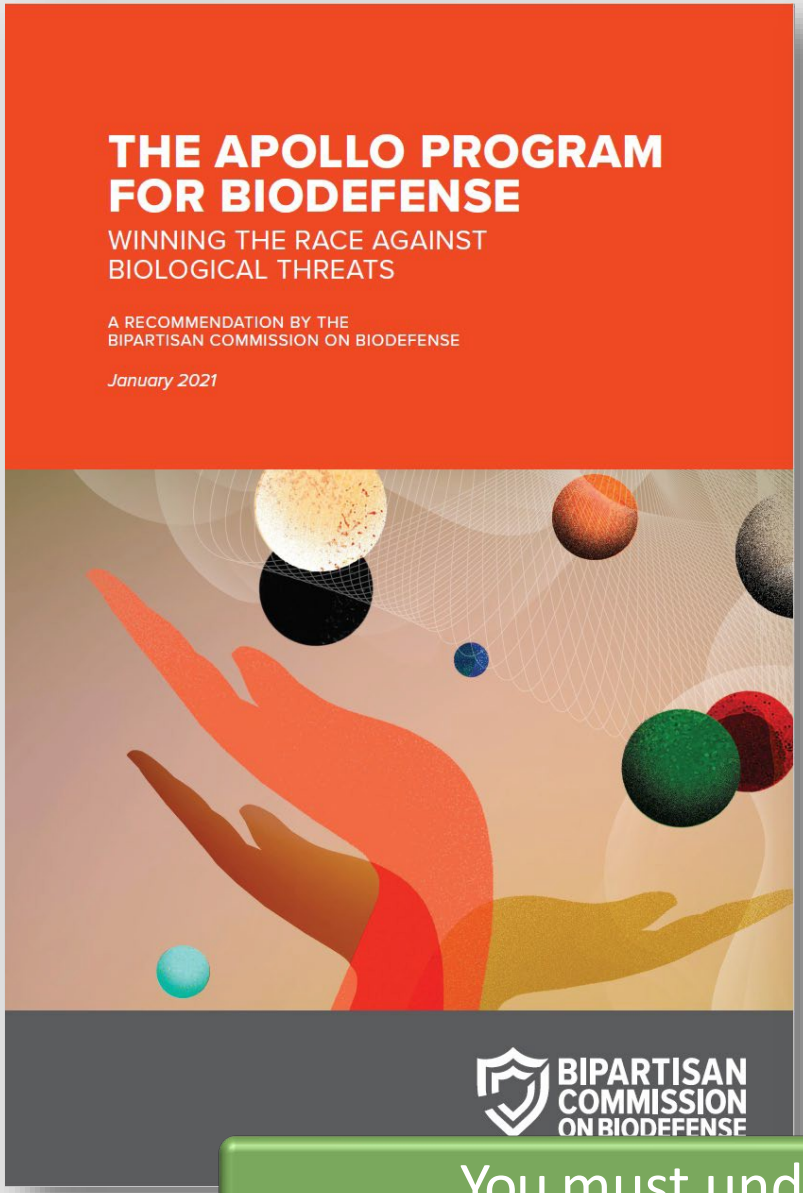
Systematic Review Article, Bioeng. Biotechnol. 06 October 2020, https://doi.org/10.3389/fbioe.2020.571672

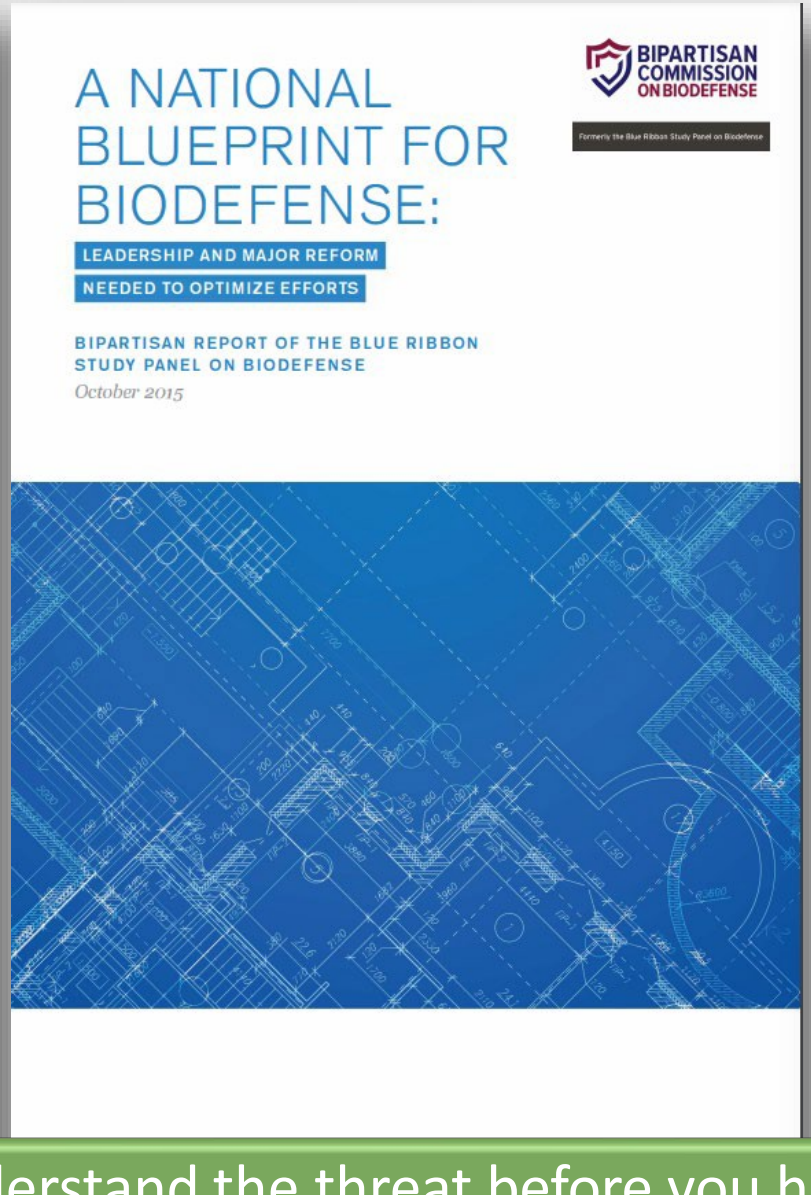
DIY BIO and Bioterrorism

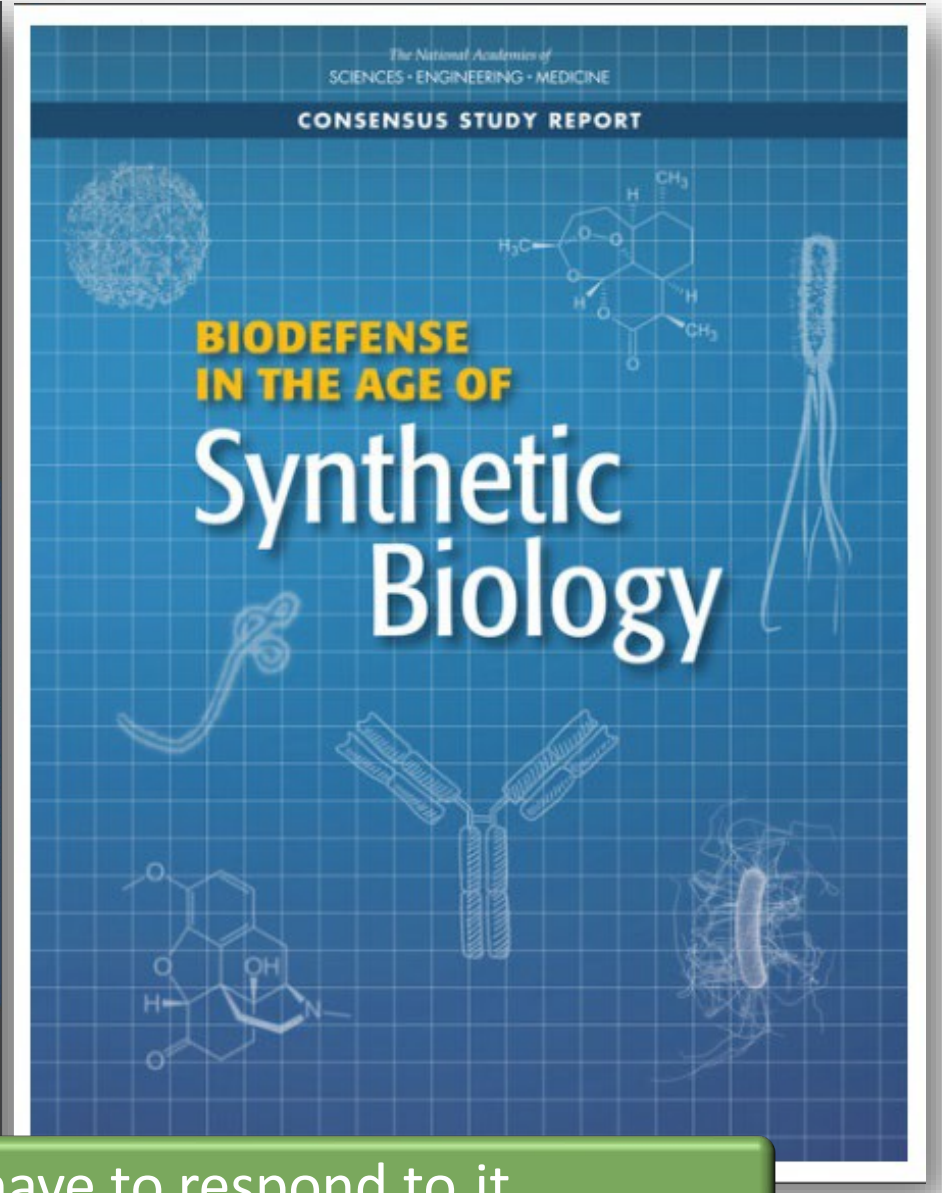
"As the cost of powerful DIY gene editing kits continues to fall, bioterrorism is going to be on the rise so we need a way to defend against it."

REF: Fanatical Futurist, July 9, 2018

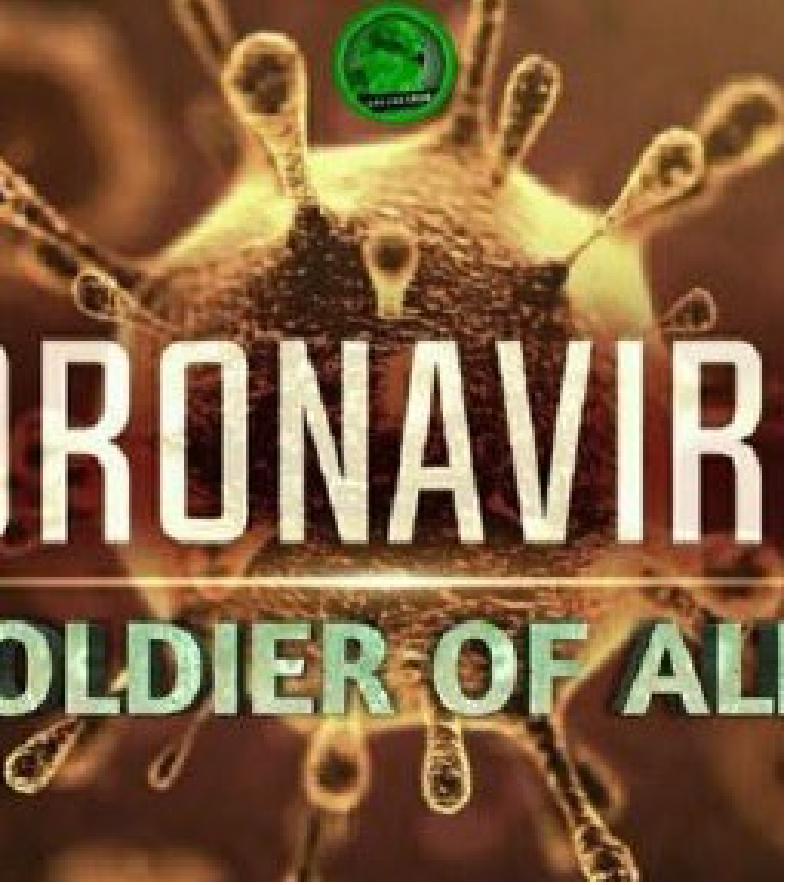
Recommended Reading

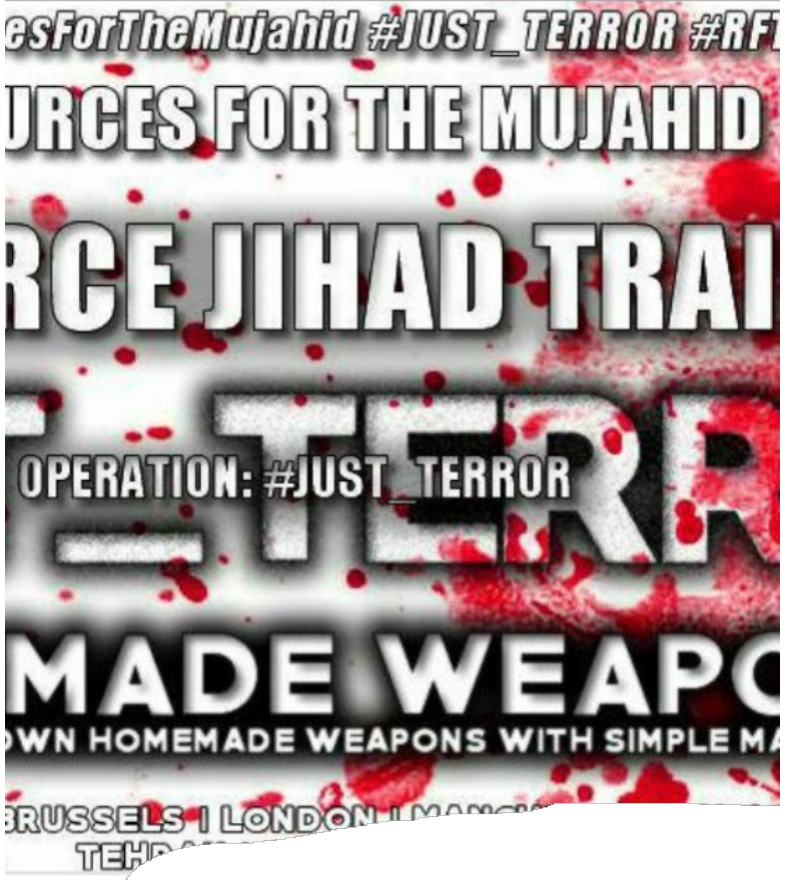






You must understand the threat before you have to respond to it





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